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A location-based prompting system to transition autonomously through vocational tasks for individuals with cognitive impairments

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ABSTRACT

This study assessed the possibility of training two individuals with cognitive impairments using location-based task prompting system in a supported employment program. This study was carried out according to an ABAB sequence in which A represented the baseline and B represented intervention phases. Data showed that the two participants significantly increased their target response, thus improving vocational job performance during the intervention phases. Practical and developmental implications of the findings are discussed.

1. Introduction

Job coaches at rehabilitation institutes serve as social workers and employment service providers. They work with individuals with cognitive impairments to support them in learning new job skills and maintaining paid employment (Bond, Drake, Mueser, & Becker, 1997; Bond & Liberman, 1992; Goodwin, 1997). They may work for weeks helping a trainee learn how to improve work quality. Even so, the individual may still require assistance of one form or the other. While at the work, trainees often need to be reminded by job coaches from the supporting group in order to keep things in control. Without proper intervention, paid job offers for many individuals with cognitive impairments have been declined because they failed to meet pre-practice task performance standards. For example, they may occasionally forget the procedures to make photocopies in an office setting or misplace salads when preparing food in kitchens.

Strategies incorporating the use of various technologies for the cognitively impaired have been developed for skill training of activities of daily living (ADL) across numerous settings (Cannella-Malone, Sigafoos, O'Reilly, de la Cruz, & Lancioni, 2006; Mechling & Ortega-Hurndon, 2007; Van Laarhoven & Van Laarhoven-Myers, 2006). Recently, supported employment programs targeted for people transitioning from institutional to community care have created more demand of cognitive aids to increase their workplace independence (Chang, Liao, Wang, & Chang, 2010; Chang, Wang, Chen, & Liao, 2011). Automatic prompting would constitute a viable approach if mild stimuli delivered through an inconspicuous device could lead the subject to complete responses without staff intervention. Such a possibility would significantly improve the subject's achievement, occupational perspectives, and level of autonomy. With proper prompts the individuals may increase their effectiveness and efficiency in skill acquisition and task performance. Moreover, it would be easily viable in terms of time and cost.

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Prompting systems provide antecedent cue regulation procedures that facilitate a shift in stimulus control from an individual to the system itself allowing the user more autonomous functioning. For example, picture prompts facilitate user performance by sequentially introducing visual depictions of task steps. Auditory prompts are recorded audio cues that facilitate user performance in completing targeted tasks and are typically delivered via portable devices (Carmien et al., 2005; Cihak, Kessler, & Alberto, 2007; Cihak, Kessler, & Alberto, 2008; Sohlberg, Fickas, Hung, & Fortier, 2007). In laboratory settings (Liu et al., 2007), field trials (Carmien et al., 2005) and community-based experiments (Gentry, Wallace, Kvarfordt, & Lynch, 2008), PDAs have been used as cognitive aids for the participating individuals with cognitive impairments.

One of the key research issues in task prompting is the timing of the prompts. Researchers are faced with challenges of when, where, and how the prompts are delivered to the users. The state of the art includes "Wizard of Oz" approaches (Liu et al., 2007; Sohlberg et al., 2007), user self-conscience (Cihak et al., 2008), or constant time delay (CTD) (Cannella-Malone et al., 2006; Gentry et al., 2008) in order to trigger the prompts for planned task steps. The "Wizard of Oz" approach involving humans to operate electronic equipment is a practice followed by some instructors when interventions are implemented (Liu et al., 2007; Sohlberg et al., 2007). It is effective but labor intensive and costly. Reminder alarms or constant time delay have proved to be useful in situations such as taking medication or fixing coffee. However, for tasks that take an indefinite amount of time, setting the timers will not be quite helpful if possible at all (Cannella-Malone et al., 2006; Gentry et al., 2008). Self-operated prompting systems require extensive training so that individuals acquire skills to identify when to invoke the prompts just in time (Cihak et al., 2008; Davies, Stock, & Wehmeyer, 2002). For example, a handheld prompting system (Cihak et al., 2008) with a hardware button to move forward to the next step was employed to transition independently through vocational tasks for individuals with intellectual disabilities. In this case, if a student forgot to press the button after finishing an assigned task, breaks in performance occurred. In addition, Taber-Doughty (2005) reported that students in some cases didn't like having to continuously press the buttons to get prompts or they simply got messed up when using a self-operated prompting system.

This motivated us to develop a more intelligent prompting system that allows fewer manual steps and shorter learning curves. By bringing ambient intelligence to prompting devices, cognitive load on users can be reduced. The proposed system for task prompting, called Locompt (a portmanteau of the words "Location" and "prompt"), is based on Bluetooth technology which many commercial smart phones such as iPhone, HTC, and Google Phone embed. A Bluetooth-enabled smart phone can sniff ambient sensors of the same type and are suitable for detecting locations. Each Bluetooth sensor has its globally unique ID, called Blue ID, which is assigned by its manufacturer. For locations to be sniffed, a Bluetooth sensor can be permanently placed in each location. A smart phone with embedded Bluetooth module can identify a location by retrieving its unique Blue ID. An individual can use the handheld system to manage vocational tasks across multiple workstations in a workplace independently. Bluetooth as assistive technology has been used in several rehabilitation methods for indoor wayfinding (Chang & Wang, 2010a, 2010b) which demonstrated viable strategies that led to automatic response and enhanced adaptation in human-machine interactions. In the Locompt system, in-house developed software is used to transition autonomously through vocational tasks for individuals with cognitive impairments. It uses Bluetooth sensors as distributed cognitive support to enable autonomous task switching across locations in a workplace. Use of this technology can free a job coach from the burden of having to constantly stay with users for vocational training.

2. Methods

2.1. Participants

Individuals of disabilities and ages in various ranges were recommended by three participating job coaches and screened according to degrees of cognitive disabilities and the ability to achieve daily living tasks. With long-term observation, the job coach decided that Yvonne and Zen were more ready to participate in experiments than the other trainees were. Yvonne, age 22, was diagnosed as having brain injury and Dementia after she had a car accident six years ago. She has received very good rehabilitation. Yvonne has been looking for but not yet found a paid job. Zen, age 27, was diagnosed as having intellectual and developmental disabilities. He has mild difficulties in memorizing routine procedures in his workplace. In addition, he occasionally gets lost and has to call for help by cellular phones. Neither of the participants had previous experience with smart phones.

2.2. Setting and the Locompt system

The Locompt system was used in a short order snack shop "Choice-to-go" supported by a community-based rehabilitation program. The smart phone, an HTC Wildfire running on the Android platform, was fastened on the lower arm. The system was programmed to be able to generate task cues in text, sound, picture or a combination of the above. Prior to experiments, the mode of task cues was input to the smart phone by the job coach according to personal preferences.

As shown in Table 1, three sets of task steps were performed by the participants to compare the performance of the baseline and intervention strategies. In each task set, there were nine task steps which fulfilled an order with desserts, beverages, and cookies. The tasks steps were similar and only differed in items and quantities. In order to pick up ordered items in correct quantities, participants visited desserts, beverages, and cookies stands one by one during their training

Table 1
Task steps at Choice-to-go.

Set	Number of steps	Task analysis
A	9	1. Start from dessert stand 2. Take 2 Boston cream pies 3. Walk to beverage stand 4. Take 1 coffee latte 5. Take 1 black tea 6. Walk to cookies stand 7. Take 5 walnut caramel cookies 8. Take 8 apricot bars 9. Walk to cashier window
B	9	1. Start from dessert stand 2. Take 3 Black forest crepes 3. Walk to beverage stand 4. Take 1 coffee cappuccino 5. Take 1 green tea 6. Walk to cookies stand 7. Take 4 almond cookies 8. Take 6 sesame seed cookies 9. Walk to cashier window
C	9	1. Start from dessert stand 2. Take 2 pumpkin pies 3. Walk to beverage stand 4. Take 1 jasmine tea 5. Take 1 ginseng tea 6. Walk to cookies stand 7. Take 7 chocolate chip cookies 8. Take 5 peanut butter cookies 9. Walk to cashier window

sessions. The three stands were located at three corners of the shop kitchen where Bluetooth sensors were deployed for the smart phone to sniff and trigger task prompts associated with the locations.

2.3. Experimental conditions

The study was carried out according to an ABAB sequence in which A represents the baseline and B represents intervention phases (Richards, Taylor, Ramasamy, & Richards, 1999). A session consisted of preparing three orders from the three work sets. Two sessions a day, one in the morning and the other in the afternoon, were observed within each study period. Sessions were taped and recorded.

2.3.1. Baseline phases

In the baseline phase, no assistive technology was applied. The job coach instructed a participant the content of an order. The participant then repeated what she heard. If there was any inaccuracy in items or quantities, the job coach corrected the participant until the content of the order was memorized without errors. Then the participant started to perform task steps at the three food stands. The job coach did not interfere with any inaccuracy in performance that the subject might have. The process repeated until three orders were completed. The number of correct task steps was counted in each session.

2.3.2. Intervention phases

In this phase, the Locompt system was used. Yvonne and Zen wore the smart phone on the lower arm. The system generated task cues in text, sound, picture or a combination of the above. Yvonne preferred vibration and picture as prompts and Zen chose sound and picture for cues. The participant used the smart phone to perform task steps at the three food stands. The job coach did not interfere with any inaccuracy in performance that the subject might have. The process repeated until three orders were completed. The number of correct task steps was counted in each session.

3. Results

Fig. 1 shows data for Yvonne. The baseline and intervention phases observed the percentage of correct task steps. During the first baseline phase (five sessions), the percentage of correct task steps was about 48%. During the first intervention phase (11 sessions), the percentage of correct task steps increased to about 98%. The percentage of correct task steps decreased to 49% during the second baseline (six sessions) and increased again, reaching nearly 99% during the second intervention phase (12 sessions). The difference of numbers of breaks between the baseline and the intervention was significant ($p < 0.05$) on the Kolmogorov–Smirnov test (Siegel & Castellan, 1988).

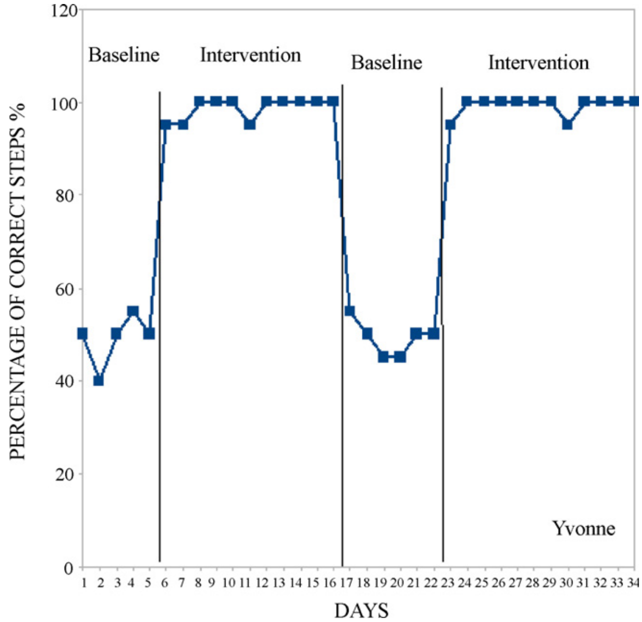

Fig. 1. Percentage of correct task steps completing snack orders for Yvonne.

Fig. 2 shows data for Zen. The baseline and intervention phases observed the percentage of correct task steps. During the first baseline phase (five sessions), the percentage of correct task steps was about 54%. During the first intervention phase (11 sessions), the percentage of correct task steps increased to about 99%. The percentage of correct task steps decreased to 55% during the second baseline (six sessions) and increased again, reaching nearly 100% during the second intervention phase (12 sessions). The difference of numbers of breaks between the baseline and the intervention was significant ($p < 0.05$) on the Kolmogorov–Smirnov test (Siegel & Castellan, 1988).

4. Discussion

This study assessed the effectiveness of the Locompt system for improving task performance using a baseline/ intervention experimental design. Results indicate that for two subjects with cognitive impairments, the Locompt system in

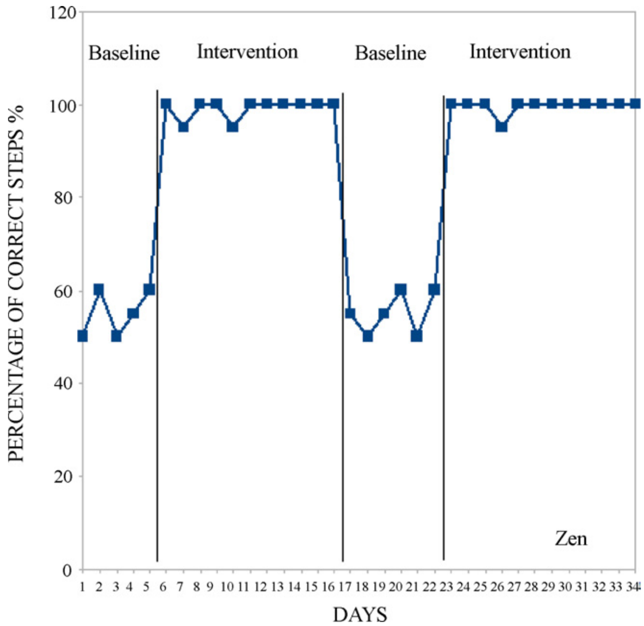

Fig. 2. Percentage of correct task steps completing snack orders for Zen.

conjunction with operant conditioning strategies may facilitate autonomous functioning of vocational jobs across multiple workstations.

During the intervention phase, the percent of correct task steps was significantly greater compared to the baseline. These results are based on two single cases. Therefore, one cannot draw too general a conclusion, although the Locompt system was useful for helping the job coach train individuals. Future work includes experiments involving more individuals with cognitive impairments and special needs.

Enhanced hardware or software assistive technology can repurpose many commercial high-technology products, turning them into high performance assistive devices to match the special needs of persons with disabilities (Chang, Peng, et al., 2010; Chang & Wang, 2010b). The prompting system in this study demonstrated the use of commercial off-the-shelf products and leveraged their many advantages, such as affordability, availability, good after-care service, good technical support, and low concern about social stigma (Chang & Wang, 2010a; Shih, Chang, & Shih, 2010a, 2010b; Shih, 2011). A smart phone in connection with location-based software technology was employed by two individuals with cognitive impairments. Evidence shows that handheld devices with location-based capabilities can be a viable task prompting tool that reduces cognitive load. This device enabled the subjects to improve their autonomous functioning in workplaces. This achievement enhances a sense of self-determination, a feeling of independence, and improves the quality of life for individuals with disabilities (Felce & Perry, 1995; Wehmeyer & Schwartz, 1998; Wessels, Dijcks, Soede, Gelderblom, & De Witte, 2003).

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